Wisconsin DNR 24K Hydrography Database Design

Version 5

Wisconsin Department of Natural Resources
Bureau of Technology Services
Last Updated: Fall 2005

What's New in Hydro Version 5?

*The FY06 release of the WDNR 24K hydro database is called 24K Hydro **Version 5**. Below is a brief overview of the types of edits and new items that are included with 24K Hydro Version 5. For more technical information about changes in the database, please refer to Appendix A of this document.*

For more detailed information on the status of hydro work activities, check out the October Hydro Newsletter located on the Hydro Home Page (http://intranet.dnr.state.wi.us/itworks/gis/hydro.asp).

- ***New attributes:***

ROW OFFICIAL NAME: *The ROW official waterbody name has been added to the arc and shaid shape files so users don't have to manually link this information from a separate dbase table.*

HYDNW924.AAT *Coverage (load source for other formats)*	**HYDLARC** *Shapefile*	**EN_SURFACE_ WATER_LN_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
ROW_NAME 70, 70 character	ROW_NAME 70 text	ROW_NAME 70 text	*ROW Name. WDNR's Official Name from the Register of Waterbodies.*

HYDNW924 .PATSHAID *Coverage (load source for other formats)*	**HYDRSHAI.SHP** *Shapefile*	**EN_SURFACE_ WATER_SHAID_ AR_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
SHDROWNAME 70, 70 character	SHDROWNAME 70 text	SHAID_ROW_ NAME 70 text	*ROW Name. WDNR's Official Name for the water area from the Register of Waterbodies.*
RIVROWNAME 70 character	RIVROWNAME 70 character	RIVER_ROW_NAME 70 text	*ROW Name. WDNR's Official Name for the river from the Register of Waterbodies.*

DATE WBIC ADDED: *Indicates the date the WBIC was first added to the hydro layer.*

HYDNW924.AAT *Coverage (load source for other formats)*	**HYDLARC** *Shapefile*	**EN_SURFACE_ WATER_LN_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
WBIC_ADDED 8, 10 date	WBIC_ADDED Date	WBIC_ADDED_ DATE Date	*WBIC Added Date. The date the WBIC was first added to the hydro layer.*

DATE WBIC ADDED cont:

HYDNW924.PAT *Coverage* *(load source for other formats)*	**HYDPPOLY** *Shapefile*	**--** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
WBIC_ADDED 8, 10 date	WBIC_ADDED Date		*WBIC Added Date. The date the WBIC was first added to the hydro layer*

HYDNW924 .PATSHAID *Coverage* *(load source for other formats)*	**HYDRSHAI.SHP** *Shapefile*	**EN_SURFACE_ WATER_SHAID_ AR_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
SWBICADDED 8, 10 date	SWBICADDED Date	SHAIDWBIC_ADDED_ DATE Date	*SHAIDWBIC Added Date. The date the WBIC for a water area (24K hydro SHAID) was first added to the hydro layer.*
RWBICADDED 8, 10 date	RWBICADDED Date	RIVSYSWBIC_ADDED_ DATE Date	*RIVSYSWBIC Added Date. The date the river system WBIC was first added to the hydro layer.*

VERSION NUMBER THE WBIC WAS FIRST ADDED: *Indicates the version of hydro to which the WBIC was first added.*

HYDNW924.AAT *Coverage* *(load source for other formats)*	**HYDLARC** *Shapefile*	**EN_SURFACE_ WATER_LN_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
WBIC_VER 3, 3 integer	WBIC_VER 9 long integer	WBIC_ADD_HYD_ VER_NO 9 long integer	*WBIC Added Hydro Version Number. The Hydro release (version) number to which the WBIC was first added.*

HYDNW924.PAT *Coverage* *(load source for other formats)*	**HYDPPOLY** *Shapefile*	**--** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
WBIC_VER 3, 3 integer	WBIC_VER 9 long integer		*WBIC Added Hydro Version Number. The Hydro release (version) number to which the WBIC was first added.*

VERSION NUMBER THE WBIC WAS FIRST ADDED cont.

HYDNW924 .PATSHAID *Coverage (load source for other formats)*	**HYDRSHAI.SHP** *Shapefile*	**EN_SURFACE_ WATER_SHAID_ AR_24K** *SDE Feature Class*	**DESCRIPTION / DOMAIN**
SWBIC_VER 3, 3 integer	SWBIC_VER 9 long integer	SHAIDWBIC_ADD_HYD_ VER_NO 9 long integer	*SHAIDWBIC Added Hydro Version Number. The Hydro release (version) number to which the water area (24K hydro SHAID) WBIC was first added.*
RWBIC_VER 3, 3 integer	RWBIC_VER 9 long integer	RIVSYSWBIC_ADD_HYD_ VER_NO 9 long integer	*RIVSYSWBIC Added Hydro Version Number. The Hydro release (version) number to which the river system WBIC was first added.*

TRACE: *A flag to indicate whether the arc should be used for tracing by the eLT for traces limited to WBIC and primary flow. This item is added to the hydltarc.shp file.*

Hydltarc.shp item name: ***TRACE***
Domain:
0 - not main channel of WBIC flow (that is, "secondary" or "stub" channels of its assigned WBIC),
1 – single, main channel flow of WBIC

- *Approximately 50 new WBICs were added since hydro release 4.*

- *WBIC change summary:*

  a.) *800 hydro features with a WBIC of zero were changed to a WBIC assigned*
  b.) *150 hydro features with an existing WBIC value were changed to WBIC of zero*
  c.) *450 hydro features with an existing WBIC value were changed to a different WBIC*

- *Approximately* ***2285*** *WBICs remain in the Register of Waterbodies (ROW) that are not represented in the hydro layer. Reasons for this are:*

  a.) *The WBIC location in ROW is bad/unusable*
  b.) *There is no water feature on the 24K hydro layer or any other map source that represents the waterbody in ROW*
  c.) *The waterbody has a status of "retired" in ROW (47 lakes, 22 reservoirs and 49 rivers)*

- *A major clean-up effort was undertaken in FY05 to fix primary flow breaks, discontinuous waterbody ID codes (WBICs), and WBIC connectivity breaks along with other edits reported by users. Improved connectivity resulted in 60 fewer independent systems (60 breaks removed), adding more than 300 miles of flow and close to 4500 acres to the waters that drain into the Great Lakes or the Mississippi*

(previously coded as "landlocked"). These fixes will significantly improve tracing results from the embeddable Locator Tool (eLT) and the SWIS Query Interface.

- *All data dictionaries have been updated and consolidated into one document Wisconsin DNR 24K Hydrography Data Dictionary.*

- *Statistics have been regenerated from the 24K Hydro data for specific subject layers (such as counties, basins and eco-regions) and are available to DNR staff through the SWIS Query Interface Hydro Stats application. Refer to http://intranet.dnr.state.wi.us/int/water/division/SWIS/SWIS_Home/swishomepage.html for more information about the Hydro Statistics available in the SWIS Query Interface.*

TABLE OF CONTENTS

I. Introduction / Overview

The Wisconsin Department of Natural Resources (WDNR) has developed a statewide 1:24,000 scale hydrography GIS database (24K Hydro) that represents all surface water displayed as blue lines and areas on the 7.5 minute US Geological Survey (USGS) topographic maps. It was developed as the key component of the Water Division's data integration plan for all water related data collected by the Department. Using this layer as a spatial framework, water related data collected from various programs within the Department will be accessible in a "clickable map" form. This new geographic query and analysis data system is called the Surface Water Integration System (SWIS).

The need for this new data layer becomes evident upon reviewing previous GIS hydro layers. The Department has had access to a statewide 1:100,000-scale hydrography GIS layer, which contains less detail. The older layer does not include many of the smaller water bodies studied or sampled by the Department. The decision to move to a larger scale (1:24K) data set was based on the fact that many staff were already using the 7.5 minute USGS topo quads to identify/locate their study areas and sample sites, instead of the less comprehensive data layer. By developing a new hydrography layer at 1:24,000 scale, the majority of water data collected by the Department could be integrated and displayed geographically.

The 24K Hydro layer was compiled from a select group of sources. The main source comes from the USGS 1:24,000-scale topographic map series. Other data sources include the Digital Line Graphs (DLGs) from USGS and Cartographic Feature Files (CFFs) obtained from the US Forest Service (USFS). Water body names have been assigned from the Geographic Name Information System (GNIS) from USGS. The Hydro layer also includes the unique WDNR Water Body Identification Codes (WBICs) from the DNR Register of Water Bodies (ROW) that are part of the legacy surface water data maintained by the Water Division.

Wetlands depicted on the 1:24,000 scale USGS maps are **not** included in the 24K Hydro layer. They can be obtained from the Digital Wisconsin Wetland Inventory http://www.dnr.state.wi.us/org/at/et/geo/datasharing/custodia/wwi_1.htm . Stream order, navigational paths, WBIC mileage systems and larger scale data from sources other than those listed previously are also outside the scope of this project.

Many other sources for hydrological features such as 1:12,000 scale USGS maps or orthographic photos do exist and may be accessible to users in other formats, but this data will not be incorporated into the Hydro layer. The data shown in the layer is also temporally static – data taken from USGS maps of a certain publication year may differ from revised or new USGS maps of different publication years.

The Hydro layer is now on its fourth data release, referred to as **24K Hydro Version 4**. Version 4 contains corrections to errors discovered in the previous release, thus increasing the accuracy of the database.

Users are invited to notify us of errors in the Hydro naming or missing or misplaced Hydro features so that this data may be accurately maintained. However, information from data sources other than those listed above will presently not be integrated into 24K Hydro.

Wisconsin DNR 24K Hydrography
DATABASE DESIGN

The following web page can provide easy access to many important 24K Hydro documents referred to throughout this document: (http://www.dnr.state.wi.us/org/at/et/geo/data/hyd24k.html#source)

II. General Information and Data Sources

General Information

- **The Projection and Coordinate System:** Wisconsin Transverse Mercator (WTM), North American Datum 1983 with a 1991 adjustment (NAD91). Linear measures are in meters. Area measurements are in square meters.
- **Precision:** The 24K Hydro data was processed at double precision.
- **Size of Coverage:** hydnw924 coverage – approximately 400 megabytes.

Data Sources

The 24K scale Hydro layer was developed primarily by capturing water features on the USGS 7.5 minute topographic quadrangle maps using a tracing program. For certain areas, however, we were able to acquire pre-existing digital data from the USGS, in the form of Digital Line Graphs (DLGs), and from the US Forest Service, in the form of Cartographic Feature Files (CFFs). Figure 1 shows the areas (by quadrangle) where these data sources differ.

In addition to the varying sources, the data also spans many years; therefore, the data will reflect the time and source differences at quad boundaries. When comparing the 24K Hydro data to the USGS quads or the Digital Raster Graphics (DRGs), the water features may not *always* match. CFFs come from US Forest Service quad maps, and are actually more current than DRGs. The data that we captured and the DLGs all come from USGS quad maps and will *usually* match the published DRGs. However, sometimes the data is older than the DRGs, and sometimes it's more current. Keep in mind that the Hydro data, no matter what the source, is a set of "snap shots in time" and may not reflect current conditions.

The source for name fields was the USGS Geographic Name Information System (GNIS) for the states of Wisconsin, Michigan, Minnesota, Iowa and Illinois. Water Body Identification Codes (WBICs) came from the Wisconsin DNR (WDNR) tabular database Register of Water Bodies (ROW).

Source information can be obtained in the 24K Hydro metadata (refer to section VIII. Metadata). More specific source, source date, and data conversion information pertaining to each arc in the database can be obtained in the hydnw924 coverage format arc attribute table (hydnw924.aat). Refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** for attribute table structures, code definitions, and descriptions. If your data set is in shapefile format, that information can be viewed in the hydlarc shapefile attribute table. Refer to the ***WDNR 24K Hydro Shapefile Data Dictionary*** for attribute table structures, code definitions, and descriptions.

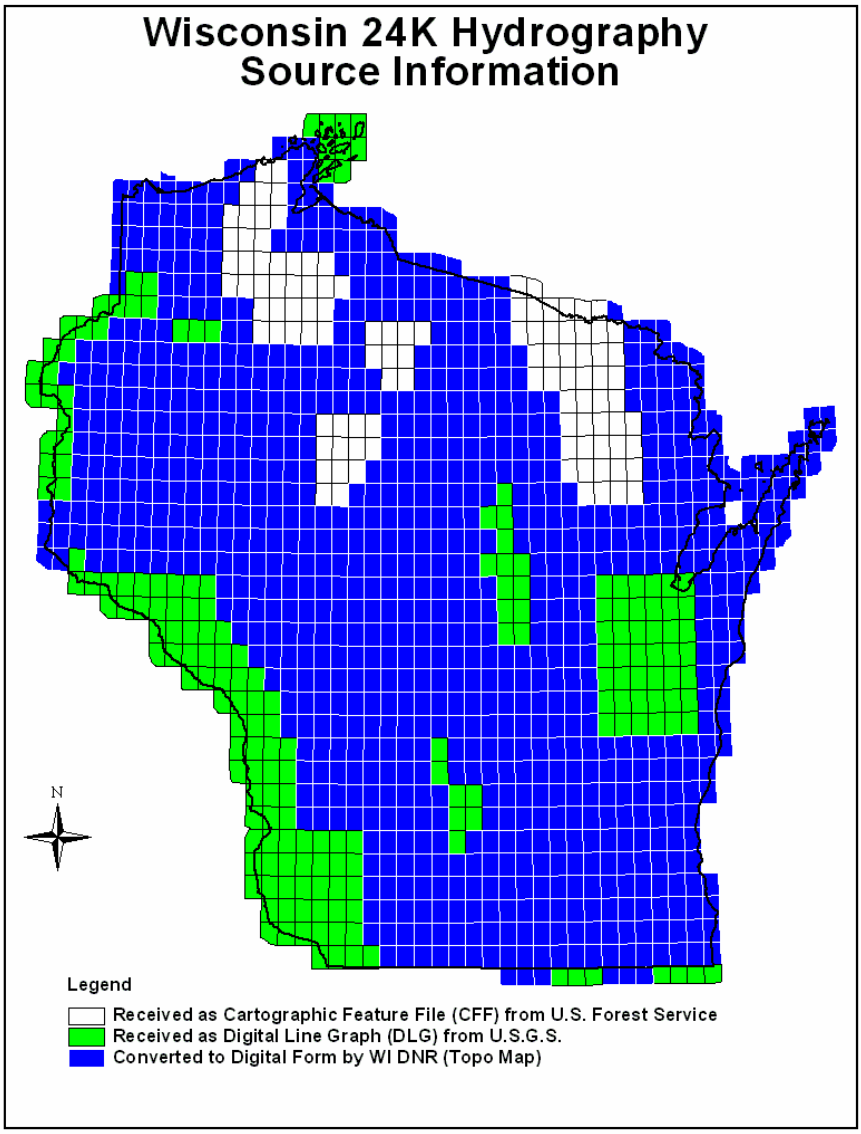


Figure 1. WDNR 24K Hydro Data Sources

III. Understanding the Hydro Data Model

When designing the Hydro database, we needed to take into consideration that the data will support many users with distinctly different needs – cartography, basic queries, intense analysis, flow modeling, network tracing, spatially anchoring user data, etc. Therefore, the data model has a "something for everyone" design, and is not application specific. However, the data model was also designed robust enough to allow for applications to be developed against the layer when those needs arise. Understanding the background, content and possible uses of this data layer will allow for users to realize its full potential. The following documentation will describe the 1:24K Hydro layer's database design concepts; an explanation of the feature classes; the Hydro network; closure lines; Water Body ID Codes (WBICs); Geographic Name Information System (GNIS) located on the Hydro features; Wisconsin DNR's (WDNR) definition of a "river system" and the tracking of data changes. The data dictionary and other more technical documentation are referred to throughout this section.

The database is available in two formats – a standard ArcInfo coverage (with arcs, polygons, routes and regions) and as a derived collection of shapefiles intended for use with ArcView. Throughout this document, *cover* or *coverage* refers to the ArcInfo product while *shapefile* refers to the ArcView data set.

The Hydro Database Design Concepts and Objectives

To meet our multi-use objectives, our database needed to represent:

- Cartographic Features that are symbolized as blue lines and areas on USGS 7.5 minute topo quads. This includes being able to distinguish between intermittent and perennial streams.
- Hydrographic Features that reflect how our brains "interpret" water features. For example, distinguishing between backwaters and rivers, flowages and a widening in a stream. Codes and names are commonly used to identify these surface water features.
- Network Features for flow analysis, modeling, and network traces, such as those for upstream/downstream types of queries.
- Spatial referencing to support positioning user data along and in water features.
- Changed Features to flag the hydrographic features that have changed from the previous release.

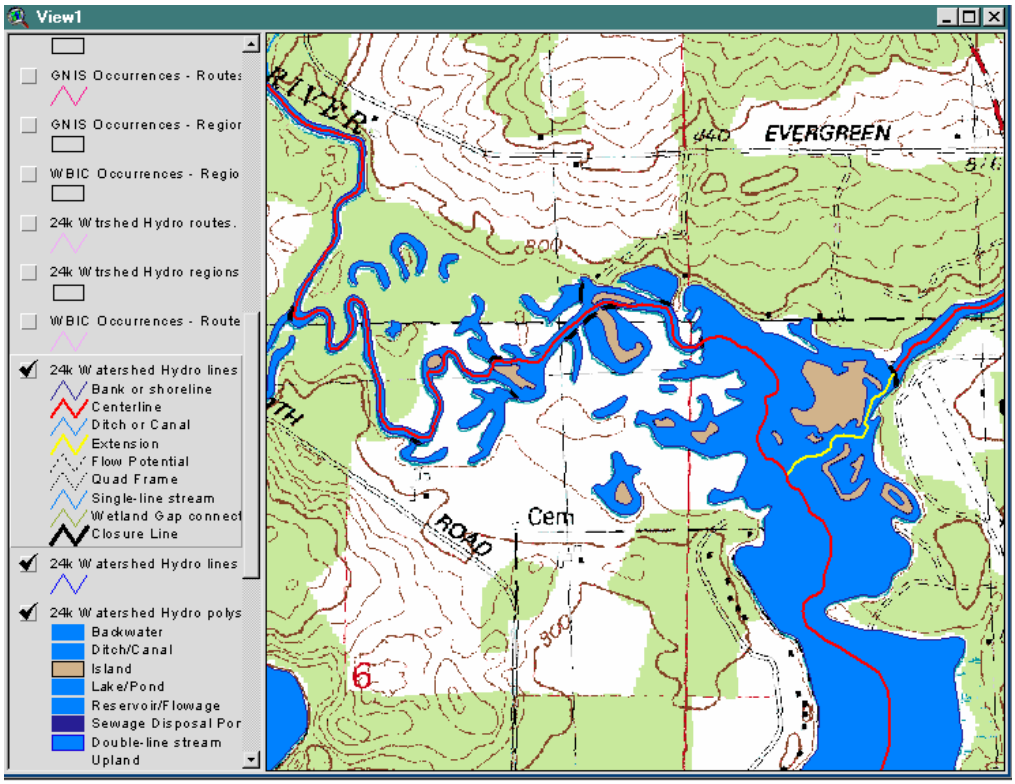
Refer to Figure 2 on the next page for an example of the database design concepts.

Figure 2.
(An ArcView session with Hydro data displayed over a DRG)

All of the blue areas represent the cartographic features.

The black closure lines depict where the water features were delineated, distinguishing from backwaters and the main river channels, for example. These represent hydrographic features.

The centerline and extensions flowing through the open water areas are examples of network features.



Hydro Feature Classes

The 24K Hydro data represents surface water found in the state of Wisconsin at a 1:24,000 scale. The data contains many different water features, such as streams, rivers, canals, lakes, ponds and reservoirs. These surface water features differ in size and complexity and hold different characteristics; therefore, they are represented in the 24K Hydro data model differently. For instance, the parts of the data model that represent rivers, streams and canals are lines or arcs. Lines represent banks and shorelines as well. The parts of the data model that represent lakes, ponds, and reservoirs are simple Hydro areas (SHAIDs which are bodies of water). Arcs and SHAIDs are examples of "feature classes" in the data model.

This section details each feature class – how they are represented in the database, which ones are most important for the user to understand, and what the descriptive attributes are and where to find more information about them.

Hydro Line Feature Classes (Arcs and Routes)

The 24K Hydro data contains many features that are represented as lines. They include streams, ditch/canals, cranberry bogs, shorelines, original water courses through flowages, channels that may exist

in water areas, and many network features for modeling flow through water areas. Each linear water feature contains useful information, such as water feature type; duration (whether it is perennial or intermittent); if it is primary or secondary flow; and whether or not it is landlocked. In addition, each line has direction (a from-end and a to-end) that points downstream for those representing flow. Some linear features also contain names from USGS's Geographic Name Information System (GNIS) and Water Body ID Codes (WBICs). The lines and their attribute information allow the user to execute spatial and tabular queries about the data, make maps, and perform flow analysis and network traces. For instance, if you want to find the Wisconsin River, you can select that waterbody name from the attribute table and the arcs that make up the Wisconsin River will be selected and highlighted. You can also look at the individual features that make up the Wisconsin River, such as Lake Wisconsin.

Arcs

The Hydro lines in the hydnw924 coverage format are known as arcs. The arcs have a corresponding arc attribute table (hydnw924.aat) where all of the attributes about the linear data reside (see Figure 3 below). Refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** for more details about the descriptive fields for linear hydrographic features.

Attributes of Hydnw924

Sw_no	Name	Wbic	Linear_typ	Quadline	Duration	Landlocked	Scdry_flow	Lr_bank	Ar_bnd_typ	Source	Oh_src_yr	Oh_col_mth	Oh_src_dsn	Xs
82805650	NA	0	XX	NO	NA	NA	NA	NA	STLP	10	0	SCR006	24000	
82805651	Unnamed	0	ST	NO	PN	NO	NO	LR	UPUP	7	1991	SCR005	24000	
46805480	North Fork Clam River	2656600	CL	NO	PN	NO	NO	NA	STST	10	0	SCR006	24000	
46805481	NA	2656600	FP	NO	PN	NO	NO	NA	STST	10	0	SCR006	24000	
82805652	Unnamed	0	BK	NO	PN	NA	NA	R	UPST	7	1991	SCR005	24000	
64815890	Unnamed	0	CB	NO	FX	NO	NO	NA	CBUP	1	1971	SCN001	24000	
64815891	NA	0	FP	NO	NA	NO	NO	NA	UPUP	10	0	SCR006	24000	

Figure 3. Arc attribute table hydnw924.aat

The Hydro lines can also be found in the hydlarc shapefile. The lines have a corresponding attribute table where all of the attributes about the linear data reside. Refer to the ***WDNR 24K Hydro Shapefile Data Dictionary*** for more details about the descriptive fields for linear hydrographic features.

Present in the arc (or line) attribute tables for coverages and shapefiles is an item called CARTO, meaning "cartography", or map-making. This item is very useful for selecting out only the linear features desired for making a map, such as shorelines and single-line streams. For specific information on how to utilize this CARTO item effectively, please refer to the ***WDNR 24K Hydro User's Guide***.

Routes - STEMs (Simple Transport Element Measurement System)

This feature class consists of linear water transport features (features that carry flow) known in the 24K Hydro data model as the STEM (Simple Transport Element Measurement) system. STEMs are an ArcInfo route system, a feature sub-class that builds upon the arc features, generating "measures" along them. In the STEM system, measurements increase upstream. Therefore, if displayed with arrows, they will point the opposite direction of water flow and the corresponding transport arcs. In the Hydro data model, the STEM class was developed for a **linear referencing system** to be used in SWIS (the DNR's Surface Water Integration System; please refer to the following web site for more information regarding SWIS http://intranet.dnr.state.wi.us/int/water/division/SWIS/SWIS_Home/swishomepage.html).This linear referencing system allows for the placement of user data along the water features that carry flow, such as

streams, ditch/canals, and connectivity features. You will not see shorelines and closure lines as a part of STEMs. They are built on the arc feature class. Refer to Figure 4 below as an example of measures along STEM routes. Notice they are opposite of flow direction.

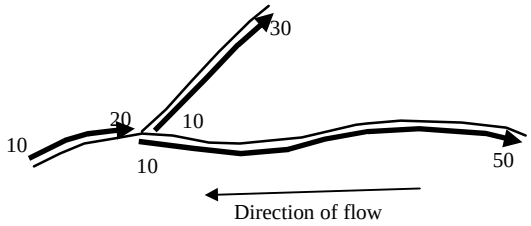


Figure 4. Route measures along arcs.

The STEM linear referencing system is similar to a street address. For the purposes of SWIS, each user data point or line gets an arbitrary "address" along the measured routes. For SWIS users, SWIS relies on a "Locator Tool" that was developed to help users more easily locate their data on the 24K Hydro layer. (Please see page 29 for more information about the Locator Tool). The user data placed along STEMs will remain in the approximate spot along Hydro even though the water course may change. This type of "dynamic" data is known as an ArcInfo "event", only to be placed along measured routes. Non-SWIS users can also utilize STEMs by establishing their own point and linear data as "events". Please refer to the appropriate ArcInfo or ArcView documentation for guidance.

Refer to ***WDNR 24K Hydro Decision Rules*** document for more technical details pertaining to STEMs.

Hydro Node Feature Class

ArcInfo's nodes are the beginning and ending points of all arcs. Please refer to Figure 5 below for an illustration of nodes.

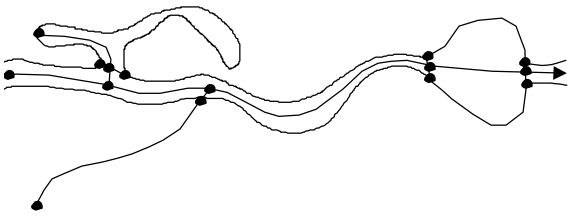


Figure 5. Nodes at beginning and ends of arcs.

Each node is attributed with a number indicating whether or not it is a "drain" of the water system. Please refer to Figure 6 below for an illustration of drain nodes.

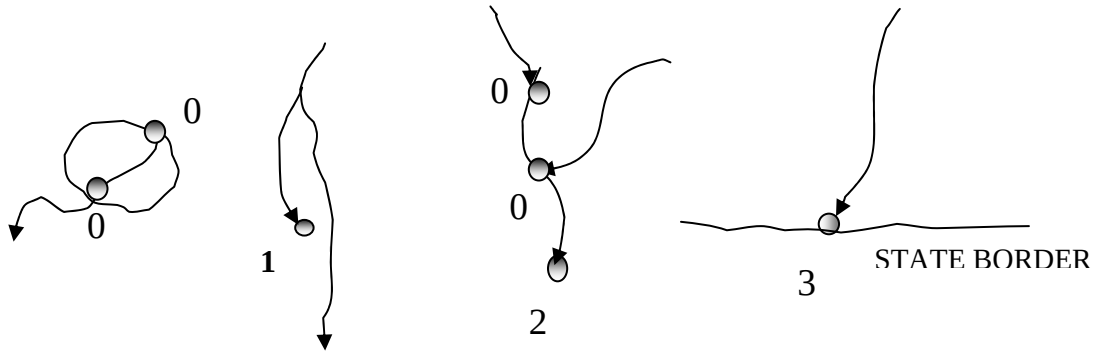


Figure 6. Drain nodes

0 Not downstream point
1 Down-stream point of non-landlocked network system (secondary drain). Occurs where downstream flow diverges and one path, which would otherwise be landlocked, terminates, usually in a wetland.
2 Down-stream point of landlocked network system (main drain).
3 Down-stream point of the *state* of non-landlocked network system (main drain)

The nodes in the hydnw924 coverage format have a corresponding node attribute table (hydnw924.nat) where all of the information about nodes resides. Refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** for more details about the descriptive fields for this feature class.

A node shapefile has not been developed because no regular need for the feature class has been determined. If you need to have the node feature class, please use the hydnw924 coverage.

Hydro Area Feature Classes (Polygons and Regions)

The 24K Hydro data contains many features that are represented as areas, including lakes, ponds, reservoirs, inundation areas, backwaters, fish hatcheries, cranberry bogs, flooded excavation sites, islands, and uplands. Also, streams are represented as areas when they widen into larger bodies of water. Each areal feature contains useful information, such as water feature type, duration (whether it is perennial or intermittent) and whether or not it is landlocked. Some area features also contain names from USGS's Geographic Name Information System (GNIS) and Water Body ID Codes (WBICs - WDNR's unique ids assigned to many water features in the state). The areas and their information allow the user to execute spatial and tabular queries about the data, make maps, and perform area analysis.

The 24K Hydro data model has two representations of areas – polygons and SHAIDs (or Simple Hydro Areas). The following information details each of these feature classes.

Polygons

ArcInfo's polygons are made up of arcs that form a closed off area. In standard ArcInfo coverages, a polygon is the smallest closed area – that is, it cannot be further divided by an intersecting line (that would create two smaller polygons). Polygons are a feature class consisting of all areas in the 24K Hydro coverage, including water polygons, uplands, and islands. They contain various descriptive attributes, including water feature types, duration (whether it is intermittent or perennial), GNIS names, Water Body ID codes (WBICs), and metadata information. The linear features (such as centerlines, extensions and closure lines) that were added to connect flow paths through the water bodies and double-line streams, split water bodies and wide streams into smaller polygons that no longer represent the complete features (see Figure 7 below).

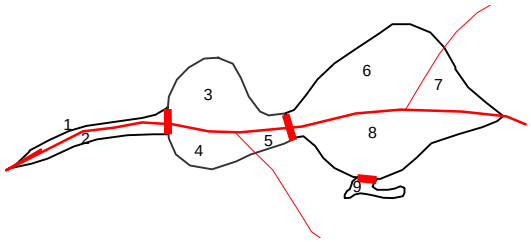


Figure 7. Linear features splitting Hydro water features into 9 polygons.

Therefore, we **do not** recommend the polygon feature class to be used for map-making, query or simple analytic purposes pertaining to water areas. The polygon feature class is primarily useful for viewing the metadata information about the individual polygons or advanced analysis requiring ArcInfo topological relationships. Use SHAIDs (discussed further in the next section) for simple analysis and cartography pertaining to water areas.

In the hydnw924 coverage format, the polygons have a corresponding polygon attribute table (hydnw924.pat) where all of the attribute information about the polygonal data resides. Refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** for more details about the descriptive fields for linear hydrographic features.

Uplands and Islands: Uplands and islands exist in the 24K Hydro coverage as attributes on the polygons (hydnw924.pat). They contain some descriptive attributes, but mostly the values are left as "not applicable" since they are not water features. Some islands may have names, but in most cases they are unnamed. Uplands do not have names. No Water Body ID Codes (WBICs) exist for islands or uplands.

Since uplands and islands are land and not water features, they do not exist on the SHAID feature class (refer to page 13 for more information on SHAIDs.)

If your data set is in hydnw924 coverage format, refer to the polygon section in the ***WDNR 24K Hydro Coverage Data Dictionary*** for more details about the descriptive fields.

If your data sets are in shapefile format, you will only have access to the polygon shapefile *upon request*, since they are mostly just used for minor metadata information pertaining to the individual polygons. Therefore, an Upland/Island Shapefile (hydrupld.shp) was developed for analysis and cartographic purposes pertaining to uplands and islands. Refer to the upland/island section in the ***WDNR 24K Hydro Shapefile Data Dictionary*** for more details about the descriptive fields

Regions - SHAIDs (Simple Hydro Area IDs)

This feature class consists of water bodies known in the 24K Hydro data as SHAIDs (Simple Hydrographic Area Identification) system. SHAIDs is the feature class to be used for cartographic and analytical purposes pertaining to water areas. Each SHAID was assigned a unique id.

The linear features (such as centerlines and extensions) that were added to connect flow paths through the water bodies and wide streams, split those water bodies and streams into smaller polygons that no longer represent the complete features (see Figure 8). Therefore, the ArcInfo region subclass SHAID was developed to aggregate those polygons so that they again represent the complete bodies of water (see Figure 9). These SHAIDs *begin and end at the closure lines and banks of water bodies*.

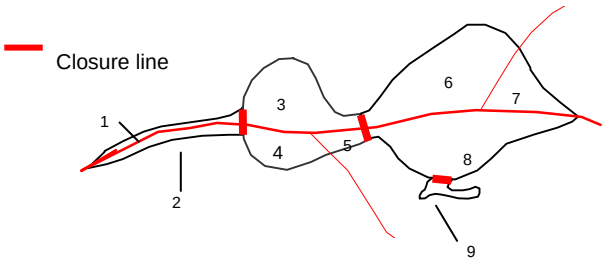


Figure 8. Linear features splitting Hydro water features into 9 polygons.

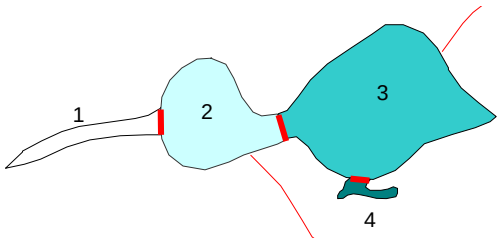


Figure 9. Water polygons aggregated into 4 SHAIDs.

SHAIDs exist on water polygons only. Islands and uplands are not included in this feature class.

SHAIDs contain useful information, such as water feature type, duration (whether it is perennial or intermittent) and whether or not it is landlocked. Some SHAIDs also contain names from USGS's Geographic Name Information System (GNIS) and Water Body ID Codes (WBICs - WDNR's unique ids assigned to many water features in the state). The SHAIDs and their information allow the user to execute spatial and tabular queries about the data, make maps, and perform area analysis.

If your data set is the ArcInfo hydnw924 coverage format, SHAIDs are in the form of the ArcInfo subclass called "regions". Regions rely upon the underlying polygon feature. SHAID regions have a corresponding SHAID attribute table (hydnw924.patshaid) where all of the attributes of the SHAID reside. Refer to the ***WDNR 24K Hydro Coverage Data Dictionary*** for more details about the descriptive fields for SHAID features.

If your data set is in shapefile format, the SHAID regions were made into a shapefile called hydrshai.shp. Refer to the ***WDNR 24K Hydro Shapefile Data Dictionary*** for more details about the descriptive fields for SHAIDs.

For more technical information about SHAIDs, please refer to the ***WDNR 24K Hydro Decision Rules*** document.

The Hydrography Network (Connectivity and Surface Water Flow)

Another objective of the 24K Hydro data model was to support flow modeling and tracing functionality, such as upstream/downstream-type queries. To accommodate this need, various "connectivity lines" (e.g. stream centerlines, extensions, wetland gap connectors, and flow potentials) were added to form a statewide linear surface water network, known as a "dendritic" network. A fully connected water network makes tracing possible, by ensuring the ability to model flow of water from one feature to another. For example, water naturally flows down a stream, through a lake, and out again to continue down the river. A connectivity line is what was added through the lake to represent the flow of the water (see Figure 10).

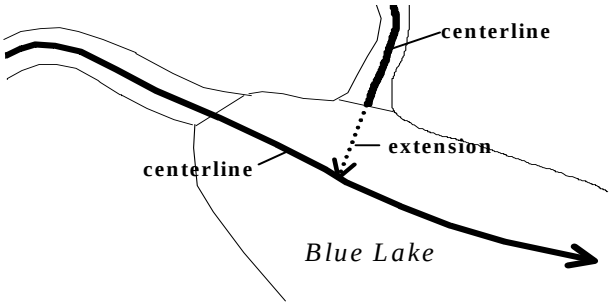


Figure 10. Example of connectivity lines (centerlines, extensions).

Connectivity lines are extremely subjective, only *approximating* the center of the open water polygon they dissect. **They are NOT intended to depict navigational paths in any way**, but were created in order to model stream connectivity. They follow the shortest and widest path around islands when multiple paths are present.

An item called FLOW in the arc attribute table indicates whether flow along the network is primary or secondary. For information on how to use the FLOW attributes for query and analysis purposes, please refer to the ***WDNR 24K Hydro User's Guide***.

Most of the connectivity features indicate where water definitely flows. However, many more subjective cases exist that we wanted to identify as *potential* flow. Therefore, a code called "Flow Potential" was established. A "Flow Potential" occurs where the flow is uncertain, but likely. The determination of whether or not flow is possible is based on the availability of other information such as contour lines and specific criteria such as the distance between the two water features. Some flow potentials fall in water bodies, such as in headwater lakes and secondary channel streams. Other flow potentials fall on land. For example, the following is a decision rule for a flow potential falling on land: "A flow potential can occur where there is a gap between two or more Hydro features, and the contour lines indicate a downhill slope, but no wetlands exist between the features. A flow potential is added as long as the distance between the Hydro features is less than or equal to 50 meters." (See Figure 11)

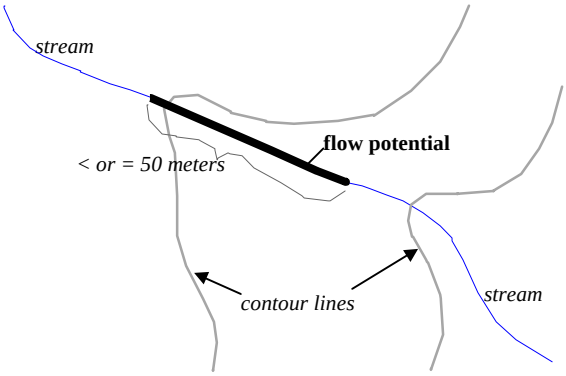


Figure 11: Example of a flow potential connectivity line.

Please keep in mind that in some instances, connectivity over land may not be established because the distance between the Hydro features exceeds 50 meters. Those features could not be connected with a degree of confidence, and were, therefore, left unconnected. To do so would be guessing as to where a stream might exist.

For a complete list of decision rules used for assigning connectivity features in the 24K Hydro network, please refer to the ***WDNR 24K Hydro Decision Rules*** document. That document contains more pictures of decision rules like the one shown above.

Important Note: Even though we have quality assured all connectivity in the Hydro network in the hydnw924 coverage, errors in the shapefile network have been discovered in the hydlarc shapefile. (This shapefile was derived from the arcs in the coverage, so the quality *should* be consistent.) The few gaps that exist in the network are due to an ArcInfo and Arc View bug in the conversion process from coverage format to shapefile.

Delineating Hydro Areas (Closure Lines)

Feature delineation and attribution is an important part of the 24K Hydro data model; therefore, the addition of "closure lines" was necessary to create what we interpret as individual water features. Closure lines are subjective lines added to support the database concept of a "hydrographic feature" – how our brains interpret the water, separating adjacent open water features of different types or names. For example, backwaters and reservoirs are closed off from the main rivers so that they can be coded as separate from the rivers – as backwaters and reservoirs. Streams are closed off from lakes, and lakes of different names are closed off from each other. Refer to Figures 12 and 13 below for closure line examples. For more closure line examples, refer to the ***WDNR 24K Hydro Decision Rules*** document.

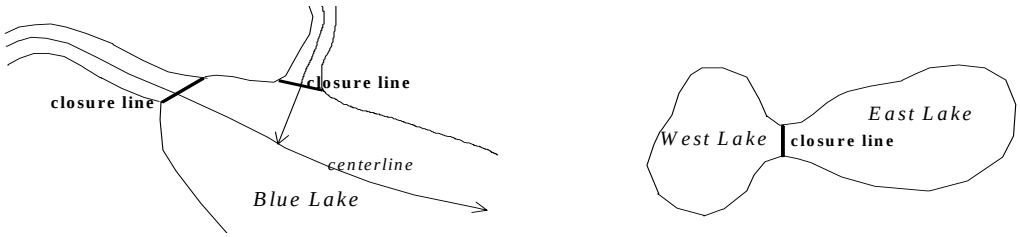


Figure 12. Closure lines cutting off a reservoir.

Figure 13. Closure line delineating 2 named areas of the same waterbody.

Water Body ID Codes (WBICs)

Water Body ID Codes (WBICs) come from an existing WDNR tabular database called Register of Water bodies (ROW), which contains an inventory of many of the surface water of Wisconsin. Before the existence of a 24K Hydro layer, many users relied on WBICs to uniquely define water features, for both linear and area water bodies. Now, WBICs have been incorporated into the 24K Hydro data model so users can search for water bodies by WBIC and graphically view the features.

WBICs are assigned to water features in ROW using one or more of the following criteria:

1) Any water feature that appears on a 7.5" topo map and is *generally* more than a mile in length or over 3 acres in area.
2) Most lakes and streams that are described in the 72 volume County Surface Water Resources Publications and are *generally* over a mile in total length or over 3 acres in area.
3) A request by DNR field personnel for a WBIC on a water feature of any length or acreage, which is on a 7.5" topo map or which they have drawn on a topo map and/or DOP based on their field observation (copy sent to the ROW file manager). Field personnel make requests for WBICs because they are doing work on particular water bodies or are stocking fish into them. For example, Fisheries and Habitat requires a WBIC for any water body that is stocked.

Wetlands can be a problem for WBIC assignment. In some cases (not many), if the USGS 7.5 minute topo maps shows a wetland but County Surface Water Resources Publications define it as a lake, the ROW file manager would have assigned it a WBIC and called it a lake. Other wetlands not defined as a lake by County Surface Water Resources Publications are *not* given a WBIC. One should remember that the topo maps represent the water of Wisconsin based on a set of aerial photos and other surveys taken at a particular time in history. This varies by topo map.

All of the WBICs in ROW are NOT necessarily included in the 24K Hydro database: WBICs were incorporated into the arcs, polygons, and SHAIDs of the layer to the extent that they matched the 24K Hydro data model. There are two reasons why some WBICs were excluded from the database:

1) Water bodies in ROW may or may not appear on the 7.5 minute topo quads. Based on the ROW file manager's three criteria above for defining a "water body" and assigning it a WBIC, the water bodies included in the ROW database are *not* scale dependent. ROW has water features that come from many different sources and scales; therefore, not all of them were included in the *1:24,000 scale* Hydro layer.
2) Some Hydro lines and areas in the 24K Hydro database were defined (or closed off) differently than in the ROW database. For example, according to ROW a closure line on a reservoir may be placed too far downstream and need to be moved; therefore, a WBIC was not assigned. Features such as this need to be reviewed before WBICs can be assigned to them. Some other water features were given WBICs but still need to be reviewed for quality assurance. The result of WBIC exclusions is that **several thousand out of approximately 28,000** WBICs in ROW did not get assigned in the Hydro database. Below are the actual statistics of WBICs in, or missing from, the 24K Hydro database.

   WBIC Statistics:
   - More than 25,500 out of 27,775 WBICs exist in the 24k Hydro database.
   - Of those included, 880 WBICs need to be reviewed for quality assurance.

- 2,000 WBICs that exist in ROW did not get assigned in the Hydro database. They are scheduled for review.

If you have any questions or concerns about WBICs, please contact Ann Schachte, ann.schachte@dnr.state.wi.us.

Water Body Names

The water body names found in the 24K Hydro layer are from the USGS Geographic Name Information System (GNIS) tabular databases for Wisconsin, Illinois, Iowa, Minnesota and Michigan. GNIS, developed by the USGS, is the federally recognized name of each feature described in the database. These are the names you *generally* see on the USGS 7.5 minute topo quads, which are the source of the 24K Hydro data database. However, not all names found on the topo quads are in GNIS, and, therefore, are not found on the 24K Hydro database. These GNIS names are the standardized naming convention used by the 24K Hydro project, and can be found in the attributes of many water features in this data layer. Where names were unavailable, water features have been labeled as "Unnamed".

GNIS names are *often* the same as those stored in the Register of Water Bodies (ROW) database *but do not always match*. ROW contains the official DNR water body names for Wisconsin surface waters and is more comprehensive than GNIS. If you are interested in linking the ROW names to the layer, please refer to the ***WDNR 24K Hydro User's Guide***.

The Concept of a River System

How one defines a river varies from person to person. Some are of the opinion that rivers are just the main flowing channels. Another opinion is that rivers include the lakes and reservoir/flowages falling along the main channel. Still others think that the miscellaneous parts, such as backwaters and inundation areas, are also part of a river. Therefore, to accommodate the various views, the 24K Hydro data model contains a concept called "river system". The two feature classes that contain the river system concept are arcs and SHAIDs. This implementation of a river system concept does not include tributaries – it is not equivalent to the full water system in a watershed or basin.

The river system concept allows users to query entire river systems by name or WBIC in the arc or SHAID feature classes mentioned previously. In the SHAID system, for example, a query for a particular river system will return all SHAIDs including lakes, reservoirs, flowages, backwaters, inundation areas and secondary channels that are part of that system. A similar query in the arc feature class would return any flow lines that exist in the previous SHAIDs (unnamed backwater and inundation area SHAIDs do not have flow lines) as well as the single-line streams that connect them. Based on those queries, reselection logic can be used to return the desired features.

The two feature attribute tables include items called RIVSYSNAME (River System Name) and RIVSYSWBIC (River System WBIC). Since arcs represent linear water features and SHAIDs represent area water features, they have slightly different definitions. Please refer to the definitions below for more information.

Note: SHAIDs also have items called SHAIDNAME and SHAIDWBIC, which will be explained in the section called *Representation of GNIS Names and WDNR's WBICs in the 24K Hydro Data Model*, page 19.

For detailed information on how to use the river system concept, please refer to *the **WDNR 24K Hydro User's Guide***.

Definition of a River System for Linear Features

A *river system for linear water features* includes the lines that carry the primary and secondary flow of the main river channel that run through all SHAIDs along that main river, and all of the lines that carry flow from or to secondary channels, named adjacent backwaters and inundation areas. Tributaries entering the main river are not included in the same river system.

In Figure 14 below, arcs 1- 5 and 7 make river system **A**. Arc 11 is river system **B**. River system B ends at the closure line of river system A; therefore, the extension from B (arc 12) is not a part of either river system. Our coding rules dictated that rivers end at the banks of the water features they flow into unless the flow of that river continues out the other end of the water body. Therefore, centerlines, such as those flowing left to right in the figure above (arcs 1, 7, 2, 3, and 4), usually continue through a water body. Extensions usually do not.

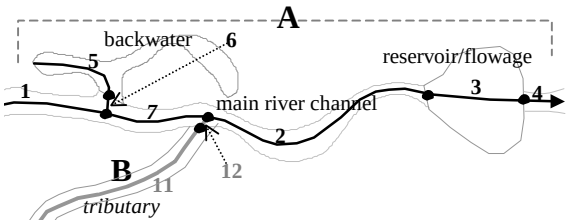


Figure 14. Arcs 1-5, 7 = river system A.
Arc 11 = river system B.
Arc 6, 12 not part of any river system

Definition of a River System for Area Features

A *river system for area water features* includes the main river channel SHAIDs plus all of the adjacent reservoir/flowage, lake, backwater and inundation area SHAIDs falling along the main river channel. Stream tributaries entering the main river are not included in the same river system. In Figure 15 below, SHAIDs 1, 2, and 3 make up river system **A**. SHAID 4 is not a part of the river system defined here because it is not included in the flow of the main river channel. SHAID 4 is part of river system **B**.

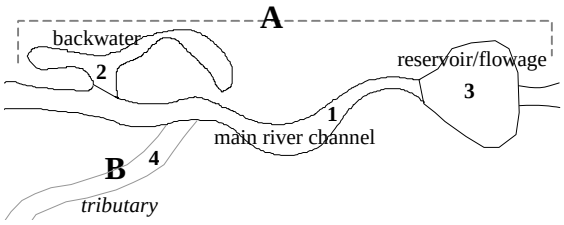


Figure 15. SHAIDs 1, 2, and 3 = river system A.
SHAID 4 = river system B.

Representation of GNIS Names and WDNR's WBICs in the 24K Hydro Data Model

GNIS Names and WDNR's WBICs are represented in the 24K Hydro data model in the arcs, polygons, and SHAID feature classes and corresponding attribute tables. ROW Official Waterbody Names are represented in the arc and SHAID feature classes. The River System concept has been applied to the representation and is reflected in the attribute table definitions. (Please refer to page 17 for the river system definition.) This allows for flexibility in query, display, and analysis. As described in the discussion on river systems, "The river system concept allows users to query entire river systems by name or WBIC that include lakes, reservoir/flowages, backwaters, and inundation areas." The items RIVSYSNAME or RIVSYSWBIC are part of the arc and SHAID attribute tables. However, if a user only wants to query on a particular body of water (a SHAID), such as a lake or flowage as opposed to a river system, that person can do so by utilizing the SHAIDNAME/SHDROWNAME or SHAIDWBIC items in the SHAID attribute table.

The following subsections detail the logic behind how names and WBICs are stored in arc and SHAID feature classes. For more information on how to use these items, please refer to the ***WDNR 24K Hydro User's Guide***.

(Please note that names and WBICs are stored in polygons but are not recommended for use in display and analysis. For an explanation of why polygons are not recommended for use, please refer to page 12. Names and WBICs are *not* stored on the linear referencing system, STEM - a STEM is for linear referencing only.)

Names and WBICs on Linear Water Features (Arcs)

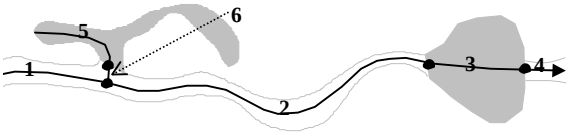
These are items pertaining to the linear river system definition that are in the arc feature class (hydnw924.aat):

RIVSYSNAME – (River System Name) The GNIS name for the "river system". (Refer to page 17 for the "river system" definition.)
RIVROWNAME – The WDNR Register of Waterbodies (ROW) Official Name for the "river system".
RIVSYSWBIC – (River System WBIC) The WBIC for the "river system". (Refer to page 17 for the "river system" definition.)

Names on Arcs

Below is an example of how GNIS Names are stored in the arc attribute table and how those names are represented geographically on the Hydro features. In this example are six arcs, five of which are coded the Yellow River. Arcs differ from SHAIDs in that SHAIDs are delineated area features. SHAIDs do not flow. Arcs carry flow; therefore, the arcs of the Yellow River main channel flow to or from the adjacent backwater and reservoir/flowage SHAIDs as the Yellow River. Five of these arcs make up the river system called the Yellow River, and the name Yellow River is stored under the item RIVSYSNAME.

Notice there is no item called SHAIDNAME in the arc attribute table. Arcs represent linear or network water features, where SHAIDs represent water areas. If a user wants name information about areas (SHAIDs), they need to look in that feature class



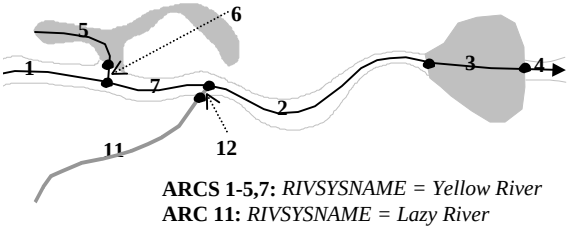
ARCS 1-5: *RIVSYSNAME = Yellow River*

Figure 16. GNIS Names assigned to Hydro (see table to right for number associations to names)

SW-NO	*RIVSYSNAME*
1	*Yellow River*
2	*Yellow River*
3	*Yellow River*
4	*Yellow River*
5	*Yellow River*
6	*NA*

SW_NO = Surface Water Number, the arc's unique id

If a tributary were to flow into a river system, that tributary would not be part of it, but would be of a different river system. Below is an example of the Lazy River entering into the Yellow River. The Lazy River is not a part of the Yellow River system. Please refer to Figure 17 below for an illustration.



ARCS 1-5,7: *RIVSYSNAME = Yellow River*
ARC 11: *RIVSYSNAME = Lazy River*

Figure 17. Naming assignment of tributaries.

SW-NO	*RIVSYSNAME*
1	*Yellow River*
2	*Yellow River*
3	*Yellow River*
4	*Yellow River*
5	*Yellow River*
6	*NA*
7	*Yellow River*
11	*Lazy River*
12	*NA*

SW_NO = Surface Water Number, the arc's unique id

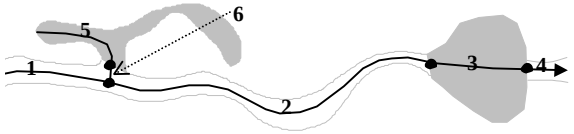
Take note of how the addition of the tributary dissected the arcs. There are now six arcs that make up the Yellow River System. Lazy River is it's own River System, and it flows into the Yellow River. The Lazy River ends at the closure line of the Yellow River; therefore, the extension from the Lazy River (arc 12) is not part of either river system. The name Lazy River will not appear on arc 12. Our coding rules were that rivers (and their names) end at the edges of the water features they flow into unless the flow of that river continues out the other end of the water body. Therefore, centerlines, such as those flowing left to right in the figure above (arcs 1, 7, 2, 3, and 4), usually continue a name through a water body. Extensions usually do not. In the arc attribute table under the item RIVSYSNAME, the value for arc 12 equals Unnamed.

Please refer to the ***WDNR 24K Hydro Decision Rules*** document for more information about how names are assigned to water features.

WBICs on Arcs

Below is an example of how WBICs are stored in the arc attribute table and how those WBICs are represented geographically on the Hydro features. In this example are six arcs, five of which are coded 1234567. Arcs differ from SHAIDs in that SHAIDs are delineated area features. SHAIDs do not flow. Arcs carry flow; therefore, the arcs of the main channel of WBIC 1234567 flow into the adjacent backwater and reservoir/flowage SHAIDs as WBIC 1234567. Arcs 1 through 5 make up the WBIC river system 1234567, and the WBIC 1234567 is stored under the item RIVSYSWBIC.

Notice there is no item called SHAIDWBIC in the arc attribute table. Arcs represent linear or network water features, whereas SHAIDs represent water areas. If a user wants WBIC information about areas (SHAIDs), they need to look in that feature class



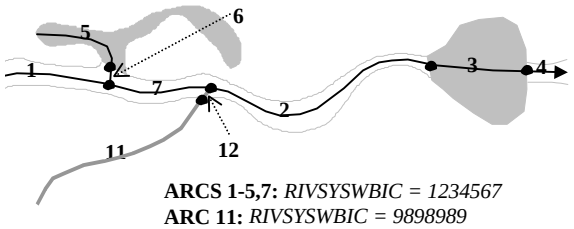
ARCS 1-5: *RIVSYSWBIC = 1234567*

Figure 18. WBIC assignment to arcs.

SW-NO	*RIVSYSWBIC*
1	*1234567*
2	*1234567*
3	*1234567*
4	*1234567*
5	*1234567*
6	*0*

SW_NO = Surface Water Number, the arc's unique id

If a tributary were to flow into a river system, that tributary would not be part of it, but would be of a different river system. Below is an example of WBIC 9898989 entering into WBIC 1234567. The WBIC 9898989 is not a part of the 1234567 WBIC river system. Please refer to Figure 19 for an illustration.



ARCS 1-5,7: *RIVSYSWBIC = 1234567*
ARC 11: *RIVSYSWBIC = 9898989*

Figure 19. Example of WBIC assignment in a river system.

SW-NO	*RIVSYSWBIC*
1	*1234567*
2	*1234567*
3	*1234567*
4	*1234567*
5	*1234567*

6	*0*	*11*	*9898989*
7	*1234567*	*12*	*0*

SW_NO = Surface Water Number, the arc's unique id

Take note of how the addition of the tributary dissected the arcs. There are now six arcs that make up the 1234567 WBIC river system. WBIC 9898989 is it's own river system, and it flows into WBIC river system 1234567. WBIC 9898989 ends at the closure line of the 1234567; therefore, the extension from 9898989 (arc 12) is not part of either river system. The WBIC 9898989 will not appear on arc 12. Our coding rules were that rivers (and their WBICs) end at the edges of the water features they flow into unless the flow of that river continues out the other end of the water body. Therefore, centerlines, such as those flowing left to right in the figure above (arcs 1, 7, 2, 3, and 4), usually continue a WBIC through a water body. Extensions usually do not. In the arc attribute table under the item RIVSYSWBIC, the value for arc 12 equals 0.

Please refer to the ***WDNR 24K Hydro Decision Rules*** document for more information about how WBICs are assigned to water features.

Names and WBICs on Area Water Features (SHAIDs)

These are items pertaining to the area river system definition that are in the SHAID feature class (hydnw924.PATSHAID):

SHAIDNAME – The name of the water body (SHAID).
SHDROWNAME – The WDNR's Register of Waterbodies (ROW) Official Name assigned to an aerial waterbody.
SHAIDWBIC – The Water Body ID Code of the water body (SHAID).
RIVSYSNAME – (River System Name) The GNIS name for the "river system". (Refer to page 17 for the "river system" definition.)
RIVROWNAME – The WDNR's Register of Waterbodies (ROW) Official Name assigned to a river.
RIVSYSWBIC – (River System WBIC) The Water Body ID Code for the "river system".

Names on SHAIDs

Figure 20 below is an example of how GNIS Names are stored in the SHAID attribute table and how those names are represented on the Hydro features. This example shows three SHAIDs – the Yellow River main channel, Upper Slough, and Green Flowage. Those names are stored under the item SHAIDNAME. All of these features make up the river system called the Yellow River. The name Yellow River is stored under the item RIVSYSNAME.

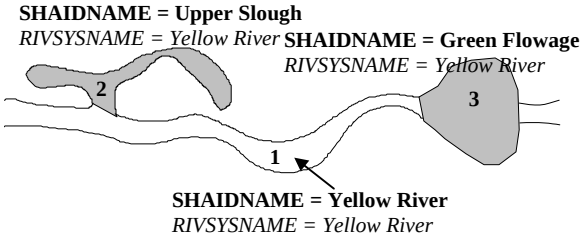


Figure 20. SHAID names in bold;
River system names in italics

SHAID-NO	SHAIDNAME	RIVSYSNAME
1	Yellow River	*Yellow River*
2	Upper Slough	*Yellow River*
3	Green Flowage	*Yellow River*

SHAID_NO = SHAID Number, the SHAID'S unique id

If a tributary were to flow into a river system, that tributary would not be part of it, but would be part of a different river system. Below is an example of the Lazy River entering into the Yellow River. The Lazy River is not a part of the Yellow River system. Please refer to Figure 21 below for an illustration.

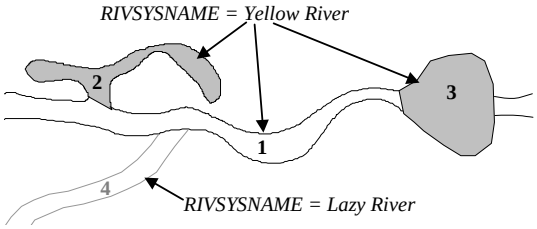


Figure 21. RIVSYSNAME assignments to SHAIDs

WBICs on SHAIDs

Figure 22 illustrates how WBICs are stored in the SHAID attribute table and how those WBICs are represented on the Hydro features. This example shows three SHAIDs with WBICs 1234567 as the main channel, 1000 as the backwater, and 5555 as the reservoir/flowage. Those WBICs are stored under the item SHAIDWBIC. All of these features make up the river system of 123567. The WBIC 1234567 is stored under the item RIVSYSWBIC.

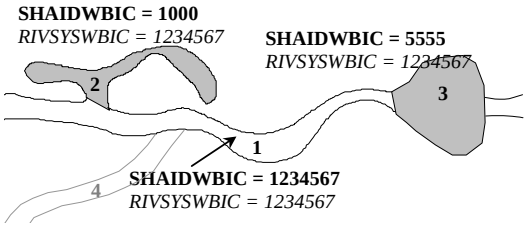


Figure 22. WBIC assignments on SHAIDs.

SHAID-NO	SHAIDWBIC	RIVSYSWBIC
1	1234567	*1234567*
2	1000	*1234567*
3	5555	*1234567*

SHAID_NO = SHAID Number, the SHAID's unique id

If a tributary were to flow into a river system, that tributary would not be part of it, but would be of a different river system. Figure 23 below is an example of the river WBIC 9898989 entering into the river WBIC 1234567. The 9898989 WBIC is not a part of the 1234567 river system.

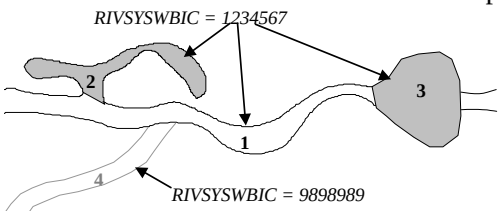


Figure 23. RIVSYSWBIC assignment to different river systems.

Change Flags

To better serve the Hydro database user community, a system was developed to give users the ability to identify specific changes in the Hydro database over time. Seven types of change flags categorize changes to the data from error corrections and updates. The change flags are on the arc, STEM and SHAID feature classes.

Change flags on arcs are Geometry Change Flag, Natural Change Flag, GNIS Change Flag, WBIC Change Flag, Reference Change Flag and Flip Change Flag. SHAIDs have only the Geometry, Natural, GNIS and WBIC change flags (they cannot be "flipped" and contain no reference data – hence, no such flags). The STEMs have Geometry and Flip Change Flags. The arc, STEM and SHAID feature classes share the NEW Features Flag.

The definitions and examples of each change flag are:

Geometry (GEOM_CHFLG) – Any dimensional or positional changes to the feature. These changes include changing length of arcs or STEMs or the area of SHAIDs.
Natural (NAT_CHFLG) – Any natural attribute changes to the feature. An example would be changing the Linear_Typ or the Duration of an arc or the Shaid_Typ on the SHAIDs.
GNIS (GNIS_CHFLG) – Any change to the GNIS item on the arcs or SHAIDs.
WBIC (WBIC_CHFLG) – Any change to the WBIC item on the arcs or SHAIDs.
Reference (REF_CHFLG) – Any change to the METADATA items like OH_SRC_YR or WBIC_BY.
Flip (FLIP_CHFLG) – Any STEM or arc that has been flipped.
New (NEW) – Any new feature created in any of the three tracked feature classes.

For more information on the types of Change Flags, please refer to the **WDNR 24K Hydro Decision Rules** document.

Database Design of the History Shapefiles

In addition to changes being flagged in the Hydro database, there are three History Shapefiles that provide more information on altered features. There is one History Shapefile each for arcs, STEMs and SHAIDs. Each History Shapefile contains only those features that have been changed in a geometric way or deleted. They show the original shape of altered or deleted features as well as carrying all the original attributes. There are four more items on each feature in the History Shapefiles.

The definitions of the four additional items are:
Flipped (FLIPPED) – Any Arc or STEM that has been flipped
Geometry changed (GEOM_CHNG) – Any feature that has been altered in Length or Area
Deleted (DELETED) – Any feature that has been removed from the previous release
Retired Date (RETIREDATE) – The date of the feature when deleted from the Hydro database

Version 3 was the first release to contain History Shapefiles. In this release of Hydro, flipped, geometrically changed or deleted features were appended to these History Shapefiles. For example, the arc History Shapefile (hyhlarc.shp) from version 3 contained any arcs that were deleted, flipped and/or geometrically changed from release 2. Version 4 contains those features plus all that were edited between Version 3 and 4. This means that an arc could end up in the History Shapefile more than once if its shape were altered in several releases. Use the Retired Date (Retiredate) and HYD_VER to identify when the feature was deleted or altered.

Data Attribution and Feature Coding Rules

Data Attribution

Each feature class in the 24K Hydro data model has a corresponding attribute table in which descriptive information is stored. For instance, the arc feature class has an attribute table containing information such as linear type, duration (whether the feature is perennial or intermittent), river system name (RIVSYSNAME from GNIS names), and river system Water Body Identification Code (RIVSYSWBIC from ROW). To keep the layer at a reasonable size and to improve query performance, the attributes in the tables are usually stored as codes. In the arc attribute table, a linear type may be ST, which means the feature is a stream; the duration may be PN, which means that feature is perennial.

We recommend the use of the 24K Hydro data dictionary to facilitate your understanding of the table structures and help you determine the meaning of the codes. Referring to the document in conjunction with the Hydro data can be very useful.

If your data is in the hydnw924 coverage format, please use the ***WDNR 24K Hydro Coverage Data Dictionary***. If your data is in shapefile format, please use the ***WDNR 24K Hydro Shapefile Data Dictionary***.

Feature Coding Rules

The 24K Hydro data model required many decision rules for consistency while defining and attributing each type of feature in each feature class. For example, a single-line stream that appears unnaturally straight or angular would be coded as a ditch/canal; a connectivity feature through a lake that flows out the other side would be coded as a centerline; and so on. Every code for each feature class has a decision rule that accompanies it. Sometimes the decision rules are straightforward and sometimes they are complex.

Please refer to the ***WDNR 24K Hydro Decision Rules*** document for more information. This document contains illustrations of each decision rule and can be very helpful in understanding the 24K Hydro data model.

IV. Overview of Hydro Shapefiles

As described previously, the 24K Hydro database is an ArcInfo coverage with a robust data model to support a variety of user needs. To further accommodate user needs, however, a series of shapefiles have also been developed from the ArcInfo coverage. These shapefiles will more easily support the use of the Hydro data in ArcView software. A set of history shapefiles also were developed to enable the tracking of changes to the Hydro database from version to version. For information on how to use the ArcInfo coverage and the resulting shapefiles, please refer to the ***WDNR 24K Hydro User's Guide***.

HYDRO SHAPEFILES

The following is an overview of the six Hydro shapefiles derived from the 24K Hydro hydnw924 coverage:

1. **hydlarc.shp** – (Hydro Line/Arc Shapefile) A shapefile containing all arcs in the 24K Hydro coverage. The arcs are attributed to easily define themes based on cartographic or modeling needs. The arcs contain names and Water Body ID Codes (WBICs). This shapefile should be used for cartographic and analytic purposes pertaining to lines, and for hydrographic modeling and network traces.
2. **hydrshai.shp** – (Hydro SHAID Shapefile) A shapefile containing all SHAIDs (Simple Hydro Areas) in the 24K Hydro coverage. SHAIDs are for Hydro features only and do not contain islands or uplands. SHAIDs contain various descriptive attributes, including names and Water Body ID Codes (WBICs). Use this shapefile for cartographic and analytical purposes pertaining to water areas.
3. **hydrupld.shp** – (Hydro Upland/Island Shapefile) A shapefile containing all upland and island polygons in the 24K Hydro coverage. This is a subset of **hydppoly.shp**. These polygons have descriptive attributes. Some islands may have names, but in most cases they are unnamed. No Water Body ID Codes exist for islands. Use this shapefile for analysis and cartographic purposes pertaining to uplands and islands.
4. **hydtstem.shp** – (Hydro STEM Shapefile) A shapefile containing all STEMs (Simple Transport Element Measurement System) in the 24K Hydro coverage. The STEM system is the linear referencing system used for dynamic placement of water-related data along linear water features that carry flow (a.k.a. transport features). STEMs only contain attributes pertaining to linear referencing. This shapefile is to only be used for linear referencing purposes.
5. **hydppoly.shp** – (Hydro Polygon Shapefile) A shapefile containing all polygons in the 24K Hydro coverage. Polygons contain various descriptive attributes, including names and Water Body ID Codes (WBICs). However, we do not recommend this shapefile for cartographic or analytic purposes pertaining to water areas. The water areas are divided into many pieces due to the addition of network features and, in many cases, do not represent complete water bodies. It also includes polygons for each isolated upland and island. Use **hydrshai.shp** for analysis and cartographic purposes pertaining to water areas, and use **hydrupld.shp** for analysis and cartographic purposes pertaining to uplands and islands.
6. **hydpmask.shp** – (Hydro Polygon Mask Shapefile) A shapefile containing a combination of the Wisconsin state boundary and the shorelines along Lake Michigan and Lake Superior. This shapefile also has an outlying box that closes off the bounding area, and, therefore, can be filled in and used as a mask. The mask is to serve the purposes of covering over the 1000 meter Hydro buffer that extends beyond the Wisconsin state boundary or out into the Great Lakes. In other words, the mask allows for a clean cut of the Hydro features along the outer limits of the Hydro layer when creating maps.

HYDRO HISTORY SHAPEFILES

The following is an overview of the three history shapefiles derived from the 24K Hydro hydnw924 coverage and the shapefiles of the previous release:

Hyhlarc.shp – (Hydro Line/Arc History Shapefile) A shapefile containing all arcs that have been flipped, geometry changed, and deleted from the 24K Hydro coverage. The arcs are attributed with these codes along with a retirement date – the date in which the features were retired from the Hydro database. The arcs also contain the original information as when it existed in the Hydro coverage, such as Water Body ID Codes (WBICs), GNIS names, linear type, and duration. This shapefile should be used for analysis of water changes over time.

Hyhrshai.shp – (Hydro SHAID History Shapefile) A shapefile containing all SHAIDs that have been geometry changed or deleted from the 24K Hydro coverage. The SHAIDs are attributed with these codes along with a retirement date – the date in which the features were retired from the Hydro database. The SHAIDs also contain the original information as when it existed in the Hydro coverage, such as Water Body ID Codes (WBICs), GNIS names, SHAID type, and duration. This shapefile should be used for analysis of water changes over time.

Hyhtstem.shp – (Hydro STEM History Shapefile) A shapefile containing all STEMs that have been flipped, geometry changed, and deleted from the 24K Hydro coverage. The arcs are attributed with these codes along with a retirement date – the date in which the features were retired from the Hydro database. The STEMs also contain the original information as when it existed in the Hydro coverage, such as unique STEM numbers and from-to route measures. This shapefile should be used for analysis of water changes over time and where the locational data once existed on these features.

V. Maintenance and History Tracking of the 24K Hydro Database

The scope of the SWIS project includes on-going maintenance of the 24K Hydro data. Due to the size and complexity of the Hydro database, errors are anticipated, such as miscoded features or missing Water Body ID Codes (WBICs). All corrections on the features are dated and flagged in the attribute tables, so for the ensuing Hydro versions you will be able to distinguish the corrected features.

Many other sources for hydrological features such as 1:12,000 scale USGS maps or orthographic photos exist and may be accessible to users in other formats, but that data will NOT be incorporated into the 24K Hydro layer.

If you would like to provide feedback on errors you have discovered, please report errors to Ann Schachte at ann.schachte@dnr.state.wi.us.

The update cycles will run **approximately** every twelve months. Each new release of the data will be documented as a new Hydro "version".

Overview of Maintenance Cycle

Handling Errors:

User-feedback – users report errors
Evaluate reported errors
Determine whether the error fits the maintenance criteria (for criteria details refer to….)
If the error meets the criteria, correct error.

Handling Updates:

USGS Quads are updated.
Update the relevant Hydro features.

Change Flagging:

All error corrections and updates made to the Hydro database in select feature classes get flagged with codes detailing the type of edit that was done, such as whether the feature's name or WBIC was changed, if it changed shape, or if a new feature was added. For more information regarding the change flags, please refer to page 24.

Post-Processing:

Once a 10-month maintenance session is coming to an end, the data is ready to be prepared for release. This preparation phase is a two-month time frame involving post-processing, quality assurance checks, documentation updates, Hydro shapefile development, and history shapefile updates.

History Tracking:

Using the change flags from the Hydro database and obtaining the deleted features from the shapefiles of the previous release, the three history shapefiles – arcs, stems, and shaids – are updated. These features retain the original information, and are populated with the nature of the change and the retirement date.

VI. Locating Hydro-related Data to 24K Hydro Features

If you are DNR staff and would like to move or locate your data to the 24K Hydro features, please visit the following website for more information about the LOCATOR TOOL (http://intranet.dnr.state.wi.us/int/water/division/SWIS/SWIS_Home/comp_ltool.html). This tool has been developed through the SWIS project to assist users in locating their data against the 24K Hydro layer. It is an ArcView extension that allows you to view your existing locations and move them to the appropriate water body. For more information on the Locator Tool, please contact Ann Schachte (ann.schachte@dnr.state.wi.us, 267-2301).

VII. Data Quality

- **Precision:** The 24K Hydro database was developed as a double precision ArcInfo coverage. Periodic quality assurance and quality control steps were included during development of the data.

- **National Map Accuracy Standards:** The 24K Hydro database meets the National Map Accuracy Standard for a 1:24,000 scale database, which is a +/- 40-meter accuracy.

- **Data Processing:** Initial data processing took place on the primary features – the arcs and polygons. Linear type, polygon type, duration, and flow codes were manually added and quality assured by editors. The quality of those attributes is very accurate. Many of the other attributes on the arcs and polygons (such as landlocked codes) were assigned in automated processes and then flagged and corrected for errors afterwards. The attributes on the SHAID region system were populated from the underlying polygons using an automated process. Measures along the STEM route system were populated using an automated process. Those attributes assigned using automated processes have undergone considerable quality control procedures, but our assurance is slightly lower than those attributes populated manually by an editor.

- **Data Sources and Time Span:** The data sources used for developing the Hydro database were scanned and vectorized (heads-up digitized) USGS 7.5 minute topographic quadrangle maps, USGS Digital Line Graphs (DLGs), and the US Forest Service Cartographic Feature Files (CFFs). The data spans many years; therefore, the data will reflect the time and source differences at quad boundaries. When comparing the Hydro data to the USGS quads or the Digital Raster Graphics (DRGs), the water features may not *always* match. CFFs come from US Forest Service quad maps, and are actually more current than DRGs. The data captured by the WDNR and the DLGs all come from USGS quad maps and will *usually* match the published DRGs. However, sometimes the data is older than the DRGs, and sometimes it's more current. Keep in mind that the Hydro data, no matter what the source, is a set of "snap shots in time" and may not reflect current conditions. For more information regarding 24K Hydro source data, please refer to page 5.

- **River Systems:** The river system concept has been applied to all rivers in Wisconsin. However, the more complex rivers, such as the Mississippi and Wisconsin Rivers, may not fully represent the river system as defined. This is because these rivers can have so many channels, backwaters, inundation areas, pools, and so forth, that checking for their complete inclusion within the systems would have exceeded our development time frame. As a maintenance task for the database, quality assurance will continue for the complex river systems, but in the meantime, please be aware of this issue when performing your queries.

- **Centerlines:** Centerlines only *approximate* the center of the open water polygons they dissect. They are NOT intended to depict navigational paths in any way, but are created in order to provide stream connectivity.

- **Closure Lines:** Closure lines were added where one water feature appears to end and another begins. Closure lines are subjective in nature and therefore may change as staff review them through use of the layer.

- **Connectivity in HYDLARC Shapefile:** Even though we have quality assured all connectivity in the hydro network in the hydnw924 coverage, errors in the shapefile network have been discovered in the hydlarc shapefile. (This shapefile was derived from the arcs in the coverage, so the quality should be consistent.) The few gaps that exist in the network are due to an ArcInfo and Arc View bug in the conversion process from coverage format to shapefile. We have identified this problem with the appropriate ESRI staff and will continue to work with them to get it addressed.

VIII. Metadata

Metadata is information about data. The 24K hydro database formal metadata contains information such as data sources, data collection methods, data collection dates, and so on. For more information about the 24K hydro metadata, please refer to the following web site provided by the Wisconsin Land Information Clearinghouse ("WISCLINC") –
http://badger.state.wi.us/agencies/wlib/sco/pages/metadata/metadata.html

APPENDIX A: Database Changes from Hydro Version 4 to Hydro Version 5

New items added:

ROW Official Waterbody Name
Date WBIC added to the hydro database
Hydro version that the WBIC was first added to

For details on these new items, please see the Data Dictionary Document *Wisconsin DNR 24K Hydrography Data Dictionary*.